Chapter 13: Aids to Navigation

Overview

Introduction

This chapter introduces the aids to navigation (ATON) used in the United States. ATON are devices or marks that assist mariners in determining their vessel's position, or course, or to warn of dangers, obstructions, or regulatory requirements affecting safe navigation. In the U.S., the Coast Guard is responsible for servicing and maintaining ATON under federal jurisdiction. This includes both short and long range navigation systems found in the navigable waters, along the U.S. coast, Intracoastal Waterway (ICW) system, and the Western Rivers system.

Lakes and inland waterways that fall under state jurisdiction use the Uniform State Waterway Marking System (USWMS).

In this chapter

These items are discussed in this chapter:

Section A. U.S. Aids to Navigation System

Overview

Introduction

Buoys, beacons, and other short range ATON are used the same way signs, lane separations, and traffic lights guide motor vehicle drivers. Together, these ATON make up the short range ATON system, which uses charted reference marks to provide information for safely navigating waterways. In the U.S., short range aids conform to IALA Region B. This can be called System B, the U.S. Lateral System, or the U.S. Aids to Navigation System. The Coast Guard maintains short range aids to provide:

- daytime visual system of daymarks, beacons and buoys;
- nighttime visual system of lights and retroreflective signals;
- radar system of radar reflectors and RACONs (radar beacons); and
- though not required by IALA, a sound system of various non-directional sound producing devices.

NOTE

"Natural ATON" are charted prominent structures or landmarks that supplement the short range ATON system. They are not a part of IALA System B, and are not a Coast Guard responsibility to service or maintain.

Appendixes 13-A through 13-D provide color representations of ATON for the various U.S. systems and how it would appear on a nautical chart.

In this section

These items are discussed in this section:

Lateral and Cardinal Significance

A.1. General

Prior to the mid-1970's, there were over 30 different navigation systems in use around the world. To reduce confusion, the International Association of Lighthouse Authorities (IALA) established two systems of buoyage for conveying navigation information to mariners. The IALA System A and B were established, with the U.S. complying with the IALA B system.

The IALA-A and IALA-B systems use the Lateral and Cardinal systems to define the conventions of buoyage, and to mark channels with ATON. "Lateral significance" or "cardinal significance" means that the rules for the Lateral or Cardinal System apply in that instance. But, if something has no lateral or cardinal significance, the respective system's rules do not apply to the situation. The differences between the markings and conventions used in the Lateral and Cardinal Systems are discussed in the following paragraphs. The following table briefly describes the IALA Systems A and B:

	Buoyage System	
	IALA-A System	**IALA-B System**
Location	Europe, Africa, Australia, New Zealand and most of Asia	North and South America, Japan, South Korea, and the Philippines
Information shown by	Buoy shapes, colors, and if lighted, rhythm of flashes and colored lights	
Topmarks	Small distinctive shapes above the basic aid that assist in identification of the aid.	
Marks	Cardinal and lateral marks	Mostly lateral, some cardinal in the USWMS
Cardinal marks have black and yellow horizontal bands regardless of the IALA system.		
When entering from seaward:		
Keep Red Buoys to	Port	Starboard, "red-right-returning"
Keep Green Buoys to...	Starboard	Port

A.2. Lateral system

In the Lateral System, buoys and beacons indicate the sides of the channel or route relative to a conventional direction of buoyage (usually upstream). They also mark junctions, a point where two channels meet when proceeding seaward; or bifurcations, the point where a channel divides when proceeding from seaward, or the place where two tributaries meet.

In U.S. waters, ATON use the IALA-B system of lateral marks with few exceptions (see Cardinal System, paragraph B.1.b.), arranged in geographic order known as the “conventional direction of buoyage”. Under this, the memory aid 3R rule of "Red, Right, Returning" applies when a vessel is returning from seaward. This means, when returning from sea, keep red markers to the right of the vessel from:

- north to south along the Atlantic Coast
- south to north and east to west along the Gulf Coast
- south to north and east to west along the Pacific Coast.
- east to west in the Great Lakes except for Lake Michigan which is north to south.

Proceeding From Seaward
Figure 13-1

A.3. Cardinal system

The Cardinal System uses a buoy to indicate the location of a danger relative to the buoy itself. In the U.S., the "Uniform State Waterway Marking System" (USWMS) uses cardinal marks on waters where a state exercises sole jurisdiction. For instance, a white buoy with a black top indicates unsafe water to the south and west. Various countries throughout the world, including Canada, Bermuda, and the Bahamas, also use Cardinal marks along with Lateral marks. Cardinal marks are not used on waters where the U.S. Coast Guard maintains short range ATON.

General Characteristics of Short Range ATON

A.4. General

Aids to navigation have many different characteristics. An aid's color, size, light, or sound signify what mariners should do when they see it. Characteristics of short range aids used in the U.S. are described in the following paragraphs.

NOTE

While reading the following section, refer to Appendix 13-A, 13-B, 13-C,and 13-D to see how the characteristics of color, numbering, lighting, and light rhythms are used on ATON to mark a waterway.

A.5. Type

The location and the intended use determine which one of the two types of ATON will be placed in a spot or waterway:

- floating (buoy); or
- fixed (beacon).

A.6. Numbering

NOTE

Preferred channel, safe water, isolated danger, special marks, and information/regulatory ATON use only letters.

Solid red ATON buoys and beacons bear even numbers and all solid green ATON bear odd numbers. No other ATON are numbered. When proceeding from seaward toward the direction of conventional navigation, the numbers increase. Numbers are kept in approximate sequence on both sides of the channel. Letters may be used to augment numbers when lateral ATON are added to channels with previously completed numerical sequences. For instance, a buoy added between R"4" and R"6" in a channel would be numbered R"4A" Letters will also increase in alphabetical order.

A.7. Color

During daylight hours, the color of an ATON indicates the port or starboard side of a channel, preferred channels, safe water, isolated dangers, and special features. Only red or green buoys, or beacons fitted with red or green dayboards, have lateral significance.

A.8. Shape

Shapes of buoys and beacons help identify them from a distance or at dawn or dusk, when colors may be hard to see. Like other characteristics of ATON, mariners should not rely solely on shape to identify an aid.

A.8.a. Cylindrical buoys (Can)

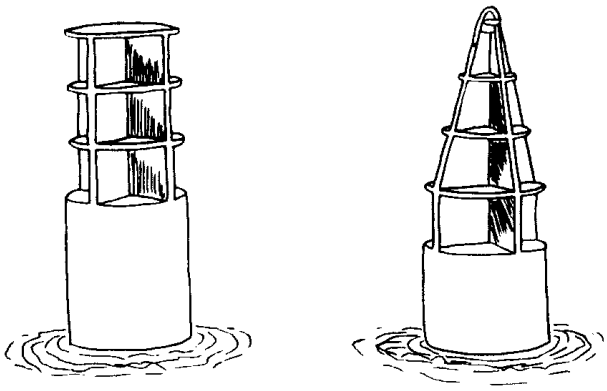
Cylindrical buoys, often referred to as "can buoys," are unlighted ATON. When used as a lateral mark, they indicate the left side of a channel or of the preferred channel when returning from seaward. They are painted solid green or have green and red horizontal bands, the topmost band is always green. Can buoys are also used as unlighted special marks and will be colored based on their use. (See Figure 13-2.)

A.8.b. Conical buoys (Nun)

Conical buoys, often referred to as "nun buoys," are unlighted ATON. When used as a lateral mark, nun buoys indicate the right side of a channel or of the preferred channel when returning from seaward. They are painted solid red or red and green with horizontal bands and always with a red topmost band. Nun buoys are also used as unlighted special marks and will be colored based on their use. (See Figure 13-2.)

NOTE

Buoys other than a "can" and "nun" or buoys fitted with a top mark, such as isolated danger or safe-water buoys, have no shape significance. Their meanings are shown by numbers, colors, top marks, lights, and sound signal



Can Buoy (left) Nun Buoy (right)
"When Returning From Sea"
Figure 13-2

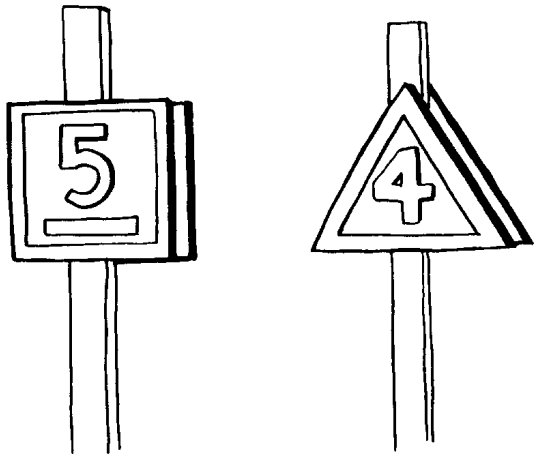
A.8.c. Miscellaneous buoys

The Coast Guard and other agencies place (station) specialty buoys for operational and developmental uses, and for research purposes. In many instances, the buoy used is a standard buoy modified for specialized use. There are several examples of specialty buoys:

- Fast water buoys
- Discrepancy buoys
- Weather/oceanographic buoys
- Mooring buoys

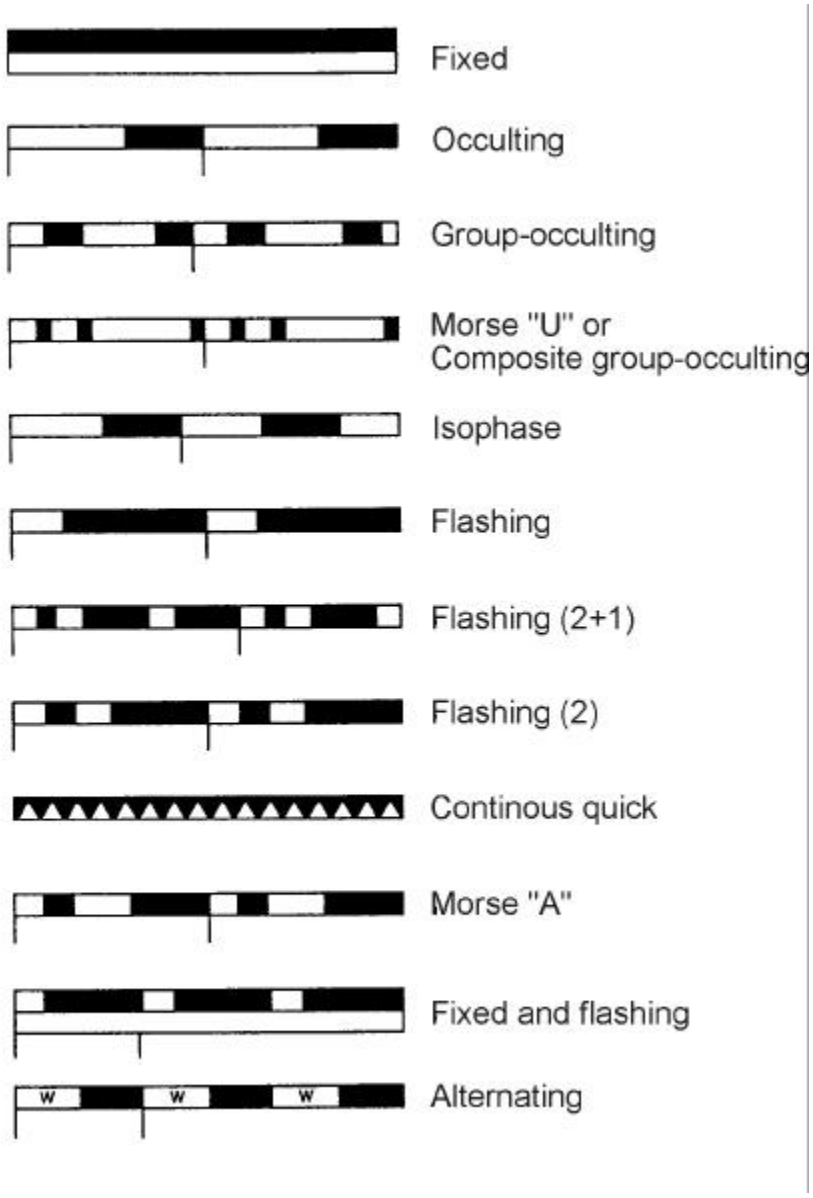
A.8.d. Beacons

Beacons have dayboards attached to a structure. When returning from sea, a triangular shaped dayboard marks the starboard side, and a rectangular shaped dayboard marks the port side of the channel. (See Figure 13-3.)



Daybeacon
"When Returning From Sea"
Figure 13-3

A.9. Light colors	Though you will see white and yellow lights, only ATON with green or red lights have lateral significance. When proceeding in the conventional direction of buoyage, ATON will display the following light colors.
A.9.a. Green	Green lights mark port sides of channels and wrecks or obstructions. When proceeding from seaward, these aids are passed by keeping them on your port side. Green lights are also used on preferred channel marks where the preferred channel is to starboard. When proceeding along the conventional direction of buoyage (from seaward), a preferred channel mark fitted with a green light would be kept on your port side.
A.9.b. Red	Red lights mark starboard sides of channels and wrecks or obstructions. When proceeding from seaward, these aids would be passed by keeping them on your starboard side. Red lights are also used on preferred channel marks where the preferred channel is to port. When proceeding along the conventional direction of buoyage (from seaward), a preferred channel mark fitted with a red light would be kept on your starboard side.
A.9.c. White and yellow	White and yellow lights have no lateral significance. However, the characteristic (rhythm) of the light does give information such as safe water, danger, or special purpose. The publication called *Light List*, discussed in another section of this chapter, provides more details.
A.10. Light signals	Lights are installed on ATON to provide signals to identify one navigation light from another, or from the general background of shore lights.
A.10.a. Light characteristics	Lights displayed from ATON have distinct characteristics which help you identify them (see Figure 13-4). ATON with lateral significance display flashing, quick, occulting, or isophase light rhythms.



Light Characteristics
Figure 13-4

A.10.b. Light identification

To identify a light, determine the following information:

Color	Color of the light beam (color of its lens).
Characteristic	Pattern of flashes or eclipses (dark periods) observed from the start of the one cycle to the start of the next cycle.
Duration	Length of time for the light to go through one complete cycle of changes.

Example: Buoy "8" displays one single flash of red every 4 seconds. That light color and rhythm information is indicated on the chart as shown below (it is underlined here for ease of identification, it is not underlined on a chart):

R"8"
Fl R 4s

A.11. Sound signals

Though not a requirement of IALA B system, in the U.S., some ATON have sound signals to provide information to mariners during periods of restricted visibility. Different types of devices are used to produce these sounds. Sound signals may be activated:

- continuously (bell, gong, or whistle buoy),
- manually,
- remotely, or
- automatically (when equipped with a fog detector).

NOTE

A bell, gong, or a whistle buoy may not produce a sound signal in calm seas.

Sound signals can be identified by their tone and phase characteristics. Horns, sirens, whistles, bells, and gongs produce distinct sound signals. The sound signal characteristics for specific ATON are briefly described on the chart, and in length in Column 8 of the *Light List*. Unless it is specifically stated that a signal "Operates Continuously" or the signal is a bell, gong, or whistle, signals will only operate in fog, reduced visibility, or adverse weather.

NOTE

Distance and direction cannot be accurately determined by sound intensity. Occasionally, sound signals may not be heard in areas close to their location.

Device	Characteristic
Tone Characteristics	
Electronic horns...	Pure tone
Sirens...	Wail
Whistle buoys...	Loud moaning sound
Bell buoys...	One tone
Gong buoys...	Several tones
Phase Characteristics	
Fixed structures...	produce a specific number of blasts and silent periods every minute.
Buoys with a bell, gong, or whistle...	are wave actuated and do not produce a regular characteristic.
Buoys with electronic horn...	operate continuously.

A.12. Retroreflective material

Most minor ATON (buoys and beacons) are fitted with retroreflective material to increase their visibility at night, especially if a searchlight is shined on them. The color of the reflective material is the same as the surface it covers (red has red, white has white material). All numbers and letters used on ATON and the outline of daymarks are retroreflective.

Summary of Lateral Significance of Buoys and Beacons

A.13. General

While proceeding in the conventional direction of buoyage in IALA System B, you will see the following ATON:

MEMORY AID

Red, Right, Returning.

A.14. Marking starboard side

Red buoys and beacons with triangular shaped red dayboards mark the starboard side of a channel when returning from seaward. This is the "red-right-returning" rule. ATON displaying these characteristics are kept to starboard when returning from seaward.

A.15. Marking port side

Green buoys and beacons with square shaped green dayboards mark the port side of a channel when returning from seaward.

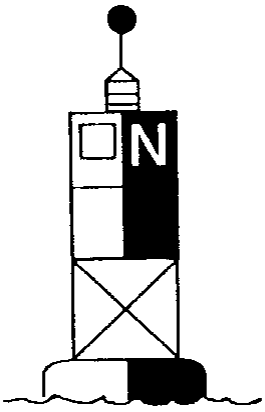
A.16. Marking channel junction or bifurcation

Red and green, or green and red, horizontally banded buoys and beacons are called preferred-channel marks. They are used to indicate a channel junction or bifurcation (point where a channel divides or where two tributaries meet). They may also mark wrecks or obstructions and may be passed on either side. When returning from sea, and the topmost band is:

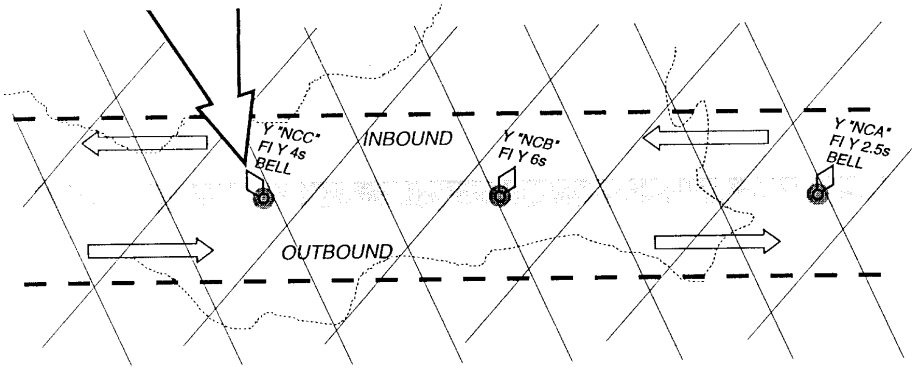
- green, keep the aid to port to follow the preferred channel, or
- red, keep the aid to starboard to follow the preferred channel.

A.17. Safe water marks

"Safe Water Marks" are buoys with alternating red and white vertical stripes, and beacons with red and white vertically striped dayboards (see Figure 13-5). They also mark a mid-channel, fairway, channel approach points and the "In" and "Out" channels of a "Traffic Separation Scheme." See buoy "N" in Figure 13-5. If lighted, they will display a white light with the characteristic Morse Code "A". Lighted marks are fitted with a red sphere as a visually distinctive top mark. Safe water marks are not laterally significant.



Safe-Water Mark
Figure 13-5



Traffic Separation Scheme
Figure 13-6

A.18. Isolated danger marks

Black and red horizontally banded buoys are called "Isolated Danger Marks". They are used to mark isolated dangers (wrecks or obstructions) which have navigable water all around. Isolated danger marks display a white light with a "group-flashing" characteristic; and are fitted with a visually distinctive topmark, consisting of two black spheres, one above the other.

NOTE

This buoy marking system is not used in the Western River System.

A.19. Special marks	Yellow buoys and beacons are called "Special Marks". They mark anchorages, dredging/spoil areas, fishnet areas, and other special areas or features. When lighted, special-purpose marks will display a yellow light with a Fixed ("F") or Flashing ("Fl") characteristic. Special marks may also be used to mark the center of the traffic separation scheme (see Figure 13-6).
A.20. Marking regulated areas	Information and Regulatory buoys and beacons indicate various warnings or regulatory matters. They are colored with white and orange shapes. (See Appendix 13-A.) They will only display a white light and may display any light rhythm except "Quick Flashing."
A.21. Marking outside normal channels	Beacons with no lateral significance may be used to supplement lateral ATON outside normal routes and channels. Daymarks for these aids are diamond shaped and will either be red and white, green and white, or black and white. (See Appendix 13-B.)

Buoys

A.22. General

Buoys are floating ATON anchored at a given position to provide easy identification by mariners. The significance of an unlighted buoy can be determined by its shape. These shapes are only laterally significant when associated with laterally significant colors such as green or red. Buoys are useful ATON, but should never be relied upon exclusively for navigation.

NOTE

As printed on nautical charts, "The prudent mariner will not rely solely on any single aid to navigation, particularly on floating aids."

When a buoy is "watching properly" it is marking its charted position "on station" and properly displaying all other distinguishing characteristics. Heavy storms, collisions with ships, and severe ice conditions may move a buoy "off station". Heavy storms may also shift the shoal a buoy marks into the channel. Remember, even heavily anchored buoys fail.

NOTE

U.S. Coast Guard Regulations states: “Coxswains shall make every effort to observe and report any ATON that is out of order or off station within a unit's area of operations.”

Beacons

A.23. General

Beacons are fixed ATON structures that are attached directly to the earth's surface. The design, construction, and characteristics of these beacons depend on their location and relationship to other ATON in the area. Strictly defined, a beacon is any fixed unlighted ATON (daybeacon) or minor light (lighted) ATON of relatively low candlepower. The following types of beacons are used in the U.S.:

- Daybeacons
- Lighted beacons (minor lights)
- Articulated lights
- Major lights
- Light towers

NOTE

Fixed aids (beacons) have a more accurate position than floating aids (buoys).

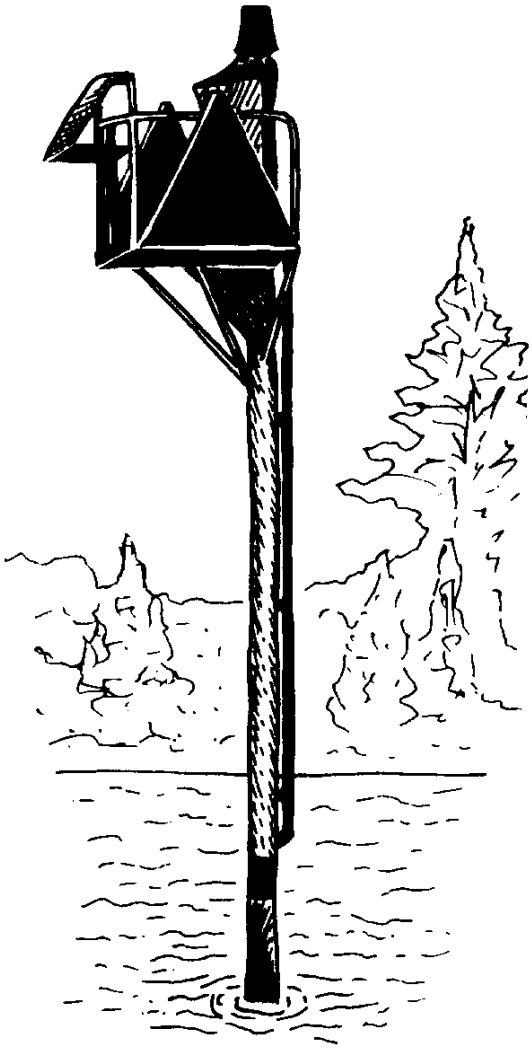
A.24. Daybeacons

Daybeacons are unlighted fixed structures fitted with a dayboard for daytime identification. To increase their visibility in darkness, dayboards are fitted with retroreflective material. Daybeacons are built on different types of structures:

- Single pile with a dayboard on the top
- Multi-pile structure
- Tower
- Structure of masonry or steel

A.25. Lighted beacons (minor lights)

Just as daybeacons are sometimes substitued for unlighted buoys, lighted beacons are substituted for lighted buoys. Their structures are similar to daybeacons (see Figure 13-7). Lighted beacons are used with other lateral aids (buoys) marking a channel, river, or harbor. In most instances, the lights have similar candlepower to those lights on buoys in the same area. They can also be used to mark isolated dangers.



Lighted Beacon (Minor ATON)
Figure 13-7

A.26. Articulated lights

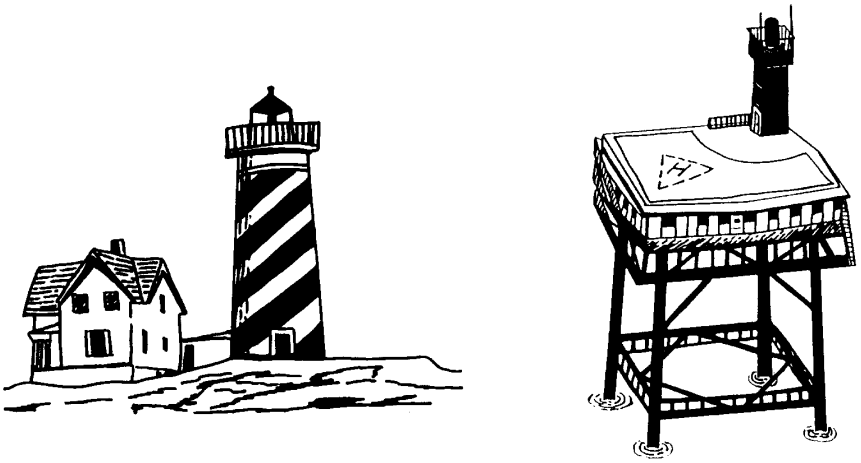
Articulated lights (beacons) are ATON structures in the water consisting of cylinders fixed to the bottom by sinkers. The cylinders are fitted with buoyant collars to keep them upright. The overall cylinder length is equal to the tidal range plus 10 to 15 feet. They are considered minor lights and fitted with the same signaling equipment as lighted beacons. When these structures are not fitted with lights, they are considered articulated daybeacons.

A.27. Major lights

Major lights display a light of moderate to high candlepower. They may also have high intensity audible signaling devices, radiobeacons and radar beacons (RACONs). Major light structures, lighthouses for instance, enclose, protect, and house their signaling devices. In their surroundings, major light structures have visually distinctive appearances (see Figure 13-8). Determining whether a light is major, or minor, depends upon its candlepower and the luminous range of the light. Lights may change their category if fitted with a higher or lower candlepower light.

Major lights rarely have lateral significance and fall into two broad categories. They are used as "Coastal or Seacoast Lights" and are often referred to as "Primary ATON." They mark headlands and landfalls and are designed to assist vessels during coastal navigation or when approaching from seaward. They are also used as "Inland Major Lights" found in bays, sounds, large rivers, and coastal approaches. As an inland major light, they serve a variety of functions:

- Obstruction mark
- Sector light
- Reference mark from which a visual bearing or range can be obtained



Lighthouse and Light Tower
Figure 13-8

A.28. Features

Major lights have the following additional features:

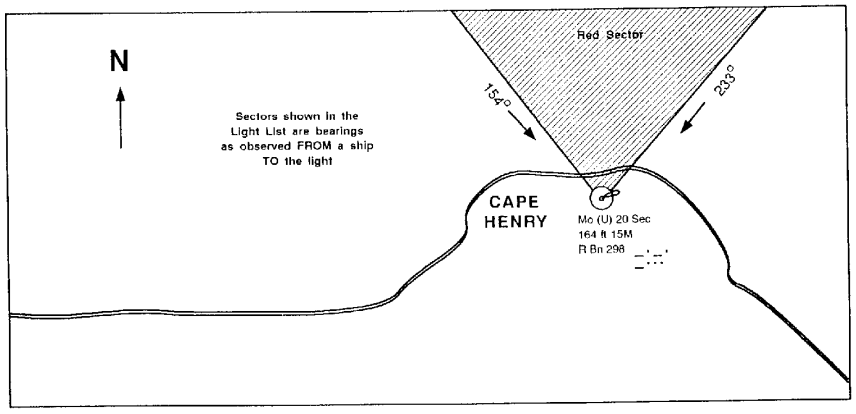
A.28.a. Sector lights

Sector lights are sectors of color that are displayed on lantern covers of certain lighthouses to indicate danger bearings. Sector bearings are true bearings and are expressed as "BEARINGS FROM THE VESSEL TOWARDS THE LIGHT." A red sector indicates a vessel would be in danger of running aground on rocks or shoals while in the sector. Red sectors may be only a few degrees in width when marking an isolated obstruction (see Figure 13-9).

A.28.b. Emergency lights

Reduced intensity emergency lights are displayed if the primary lights are extinguished. They may or may not have the same characteristics as the primary lights. The characteristics of emergency lights are listed in Column 8 of the *Light List* (see Figure 13-9).

(1) No	(2) Name and location	(3) Position	(4) Characteristic	(5) Height	(6) Range	(7) Structure	(8) Remarks
	SEACOAST (Virginia) – Fifth District						
	OCEAN CITY INLET TO CAPE HATTERAS (Chart 12200)	N/W					
365	*Navy SESEF Lighted Buoy A*	36 55.0 75 38.3	Fl Y 2.5^{s}		5	Yellow	
370	**Cape Henry Light**	36 55.6 76 00.4	Mo (U) W 20^{s} **(R sector)** 1^{s} fl 2^{s} ec. 1^{s} fl 2^{s} ec. 7^{s} fl 7^{s} ec.	164	W 17 R 15	Octagonal pyramidal tower, upper and lower half of each face alternately black and white. 163	Red from 154° to 233° covers shoals outside Cape Charles and Middle Ground inside bay. Emergency light of lower intensity will be displayed when main light is extinguished



Sector Light
Figure 13-9

A.29. Light towers

Light towers replaced lightships and are located in deep water to mark shoals and heavily traveled sea lanes. The foundation or legs of these towers are fixed to the bottom. They are equipped with signals comparable to major lights.

A.30. Ranges

Ranges are pairs of beacons located to define a line down the center of a channel or harbor entrance. They are usually lighted and arranged so that one mark is behind and higher than the other mark. When both markers of the range are in line, a vessel's position is along a known line of position. Ranges are located on specially built structures, existing ATON structures, or structures such as buildings or piers. Ranges are found in entrance channels to harbors, piers, or successive straight reaches. Again, range marks are located so that when viewed from the channel the upper mark is above, and a considerable distance beyond, the lower mark.

IF . . .	**THEN . . .**
the two marks are vertically aligned	the upper (rear) mark appearing directly above the lower (front) mark, the vessel is in the center of the channel (see Figure 13-10).
the upper mark is seen to the left of the lower mark,	the vessel is to the left of the center of the channel.
the upper mark is to the right of the lower mark	the vessel is to the right of the center of the channel.

A.30.a. Characteristics

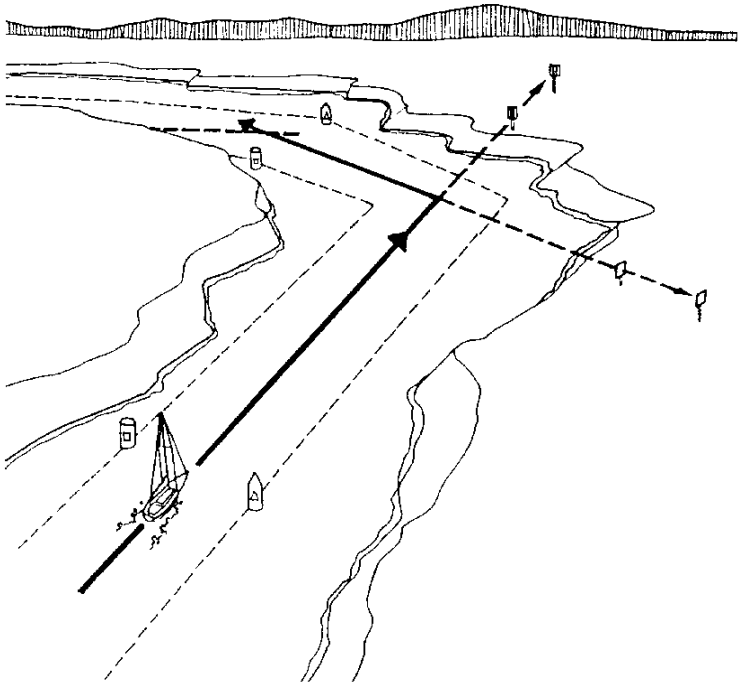
Ranges have rectangular daymarks that are striped in various colors. They are non-lateral ATON and when lighted, may display either red, green, or white lights or combinations of the same. Consult the *Light List* for the light characteristics and color combinations displayed on the daymarks.

CAUTION !

The limits of a range can only be determined by checking the chart. They show the fairway or reach of the channel marked by the range. This area will be marked by a “Leading Line” (solid line) on the chart. At the turn, the range will be marked by a spaced line (See Figure 13-10).

A.30.b. Directional lights

Some structures have a directional light, a single light with a special lens, with a narrow white light beaming in a specific direction. On either side of the white beam is a red or green light. The width of the sector varies with the particular location. The *Light List* and chart should be checked for specific information.



Using Range Lights
Figure 13-10

Section B. U.S. ATON System Variations

Introduction

Though the system of ATON used in the U.S. and its territories consists of buoys and beacons conforming to IALA System B requirements; the waterway systems in the U.S. have variations that are exclusively used in the U.S. system.

- Appendix 13-A: The U.S. Aids to Navigation System as Seen Entering From Seaward.
- Appendix 13-B: A Visual Buoyage Guide for System B.
- Appendix 13-C: How the Visual Guide Would Appear on a Nautical Chart.
- Appendix 13-D: Aids to Navigation Used on the *Western River System* and the *Uniform State Waterway Marking System*.

In this section

These items are discussed in this section:

Intracoastal Waterway and Western Rivers

B.1. Intracoastal waterway

Extending some 2,400 miles along the Atlantic and Gulf coasts of the U.S., the Intracoastal Waterway (ICW) is a largely sheltered waterway, suitable for year-round use. ATON used to mark the ICW use the following characteristics:

- Special markings consisting of yellow squares and triangles are used so that vessels may readily follow the ICW.
- The yellow square shows that the aid should be kept on the left side when traveling North to South/East to West.
- The yellow triangle shows that the aid should be kept on the right side when traveling North to South/East to West.
- The coloring, numbering, and conventional direction of buoyage conform to marks used in the U.S. ATON System, with an exception:
- Non-lateral aids in the ICW, such as ranges and safe-water marks, are marked with a yellow horizontal band.

B.2. Western rivers

The "Western Rivers" marking system is used on the Mississippi River and tributaries above Baton Rouge, Louisiana, and certain other rivers which flow towards the Gulf of Mexico. The Western Rivers system varies from the U.S. ATON System:

- Buoys are not numbered.
- Lighted beacons and daybeacons are numbered but have no lateral significance. (The numbers relate to the distance up or downstream from a given point in statute miles).
- Red and green diamond-shaped daymarks as appropriate are used to show where the channel crosses from one side of the river to the other.
- Lights on green buoys and beacons are colored green or white (for crossings) and have a flashing (Fl) characteristic.
- Lights on red buoys and beacons are colored red or white (for crossings) and have a group flashing (Gp Fl) characteristic.
- Isolated danger marks are not used.

Uniform State Waterway Marking System

B.3. General

The Uniform State Waterway Marking System (USWMS) is designed for use by many types of operators and small vessels on lakes and inland waterways not shown on nautical charts. The conventional direction of buoyage in the USWMS is considered upstream or towards the head of navigation. This system has two categories of aids:

- System of ATON compatible with, and supplements the U.S. lateral system in states' waters, not federal jurisdiction. (See a. and b. below).
- System of regulatory markers that warn of danger or provide general information and directions (see B.6. below).

NOTE

USWMS marks may be used by the state or private individuals on waters where both state and federal governments have jurisdiction. These marks are classified as "Private" ATON and require Coast Guard authorization prior to establishment. The location or characteristics of these marks are often found in the *Light List*.

B.4. USWMS variations

There are three USWMS variations to the U.S. ATON System:

- On a well-defined channel, solid colored red and black buoys are established in pairs (gate buoys), marking each side of the navigable channel.
- The color black is used instead of green.
- The shape of the buoy has no significance.

B.5. USWMS cardinal marks

When there is no well-defined channel or when there is an obstruction whose nature and location allows it to be approached by a vessel from more than one direction, ATON with cardinal marks may be used. The USWMS provides for three aids with marks that have cardinal significance:

- A white buoy with a red top represents an obstruction and the buoy should be passed on the south or west.
- A white buoy with a black top represents an obstruction and the buoy should be passed to the north or east.
- A red and white vertically striped buoy indicates an obstruction exists between that buoy and the nearest shore.

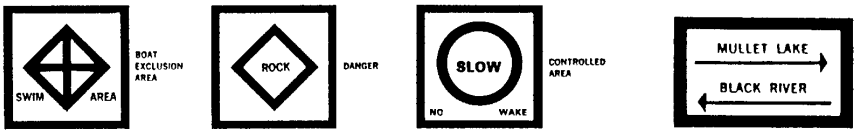
B.6. USWMS regulatory marks

USWMS regulatory marks are white with two international orange horizontal bands completely around the buoy circumference. One band is near the top of the buoy while the second band is just above the waterline. Geometric shapes are placed on the buoy's body and are colored international orange (see Figure 13-11). There are four basic geometric shapes authorized for these marks and each one has a specific meaning associated with it. These are:

NOTE

Regulatory marks are displayed on beacons as well as buoys.

- A vertical open-faced diamond shape means danger.
- A vertical open-faced diamond shape having a cross centered in the diamond means that vessels are excluded from entering the marked area.
- A circular shape indicates a control zone where vessels in the area are subject to certain operating restrictions.
- A square or rectangular shape is used to display information such as direction and/or distances to a location. (Information and regulatory marks can also be used in waters outside USWMS waters, e.g., federal channels which use the U.S. ATON system.)



Regulatory Mark Information Mark
Figure 13-11

B.7. USWMS mooring buoys

Mooring buoys in USWMS are white with a horizontal blue band midway between the waterline and the top of the buoy, and display a slow-flashing white light when lighted. Mooring buoys in federal waters (U.S. ATON system) also display white with a horizontal blue band.

Section C. Short Range Electronic Aids

C.1. General

Electronic systems are supplemental systems that are very useful when visibility is restricted or when mariners are beyond the sight of land. There are two commonly used types of short range electronic aids to navigation:

- Radiobeacons
- Radar Beacons

NOTE

All navigation systems are not perfect, so a rhyme for the wise: “A mariner who relies solely on one navigation system, may soon find they are way off position.”

C.2. Radiobeacons

Marine radiobeacons are the oldest electronic aid to navigation. They are homing beacons whose signals are received by radio direction finders. They transmit a radio signal in the low to medium frequency band of 285 to 325 kilohertz (kHz) that has a distinctive Morse Code signal and that is audible to the direction finding equipment.

The location of radiobeacons is shown on a nautical chart by the abbreviation "RBn" and a circle. The transmission characteristics of radiobeacons are found in the appropriate *Light List*.

Marine radiobeacons only provide bearing information to the transmitter site. These radiobeacons are being phased out by the Coast Guard. In the year 2000, the only remaining marine radiobeacons should be those used for transmitting Differential Global Positioning System (DGPS) corrections. (DGPS is discussed later in this chapter.)

C.3. Radar beacons

RACON is an acronym for Radar Beacon. These beacons transmit a Morse Code reply when triggered by a boat's radar signal. This reply “paints” the boat's radar screen in the shape of dashes and dots representing a specific Morse Code letter, usually beginning with a dash. The "paint" signal appears on the radar screen showing the Morse Code signal beginning at a point just beyond the location of the RACON transmitter location and extending radially for one to two nautical miles.

Transmission characteristics of RACONs may be found in the appropriate *Light List*. RACONs are shown on nautical charts with the letters "RACON" and a circle. RACONs are more useful than radiobeacons because they provide information on both bearing and range to the transmitter site.

Section D. Radionavigation Systems

Overview

Introduction

Radionavigation systems are used by mariners for obtaining a position fix. Depending upon their range and accuracy, some systems can be used in the middle of an ocean, or while entering a difficult harbor approach. All of the systems transmit a signal from a land or space-based transmitter to a shipboard receiver, allowing mariners to determine their position. The most recognizable systems are Loran-C, Global Positioning System (GPS), and the Differential Global Positioning System (DGPS).

In this section

These items are discussed in this section:

Loran-C

D.1. General	Derived from the words LOng RAnge Navigation, Loran-C is a navigation system network of transmitters consisting of one master station and two or more secondary stations. Loran-C is a pulsed, hyperbolic (uses curved lines) system. Loran-C receivers measure the Time Difference (TD) between the master transmitter site signal and the secondary transmitter site signal to obtain a single Line of Position (LOP). A second pair of Loran-C transmitting stations produces a second LOP. Plotting positions using TDs requires charts overprinted with Loran-C curves. However, many modern Loran-C receivers convert Loran-C signals directly into a readout of latitude and longitude, the mariner then can use a standard nautical chart without Loran-C curves.
D.2. Accuracy	Loran-C is accurate to better than .25 nautical miles (NM) and available better than 99.9% of the time for each station. When used to return to a position with known TDs, Loran-C can produce an accuracy to within 20 meters (60 feet).
D.3. Area coverage	U.S. and Canadian coastal areas are covered by Loran-C transmitter sites controlled by the U.S. Coast Guard. Loran-C is used by other countries and provides coverage for most of the North Atlantic, Europe, Mediterranean Sea, Japan, China, and Korea.

Global Positioning System (GPS)

D.4. General

The Global Positioning System (GPS) is a system of 24 satellites operated by the Department of Defense (DoD). It is available 24 hours per day, worldwide, in all weather conditions. Each GPS satellite transmits its precise location, meaning position and elevation. In a process called "ranging," a GPS receiver on the boat uses the signal to determine the distance between it and the satellite. Once the receiver has computed the range for at least four satellites, it processes a three-dimensional position that is accurate to about 100 meters. GPS provides two levels of service - Standard Positioning Service (SPS) for civilians users, and Precise Positioning Service (PPS) for military users.

D.5. Standard positioning service

The civilian SPS is available on a continuous basis to any user worldwide. It is accurate to a radius within 100 meters of the position shown on the receiver about 99% of the time.

D.6. Precise positioning service

PPS provides positions fixes accurate to within 21 meters. This service is limited to approved U.S. Federal government, allied military, and civil users.

Differential Global Positioning System (DGPS)

D.7. General

The Coast Guard developed Differential Global Positioning System (DGPS) to improve upon SPS signals of GPS. It uses a local reference receiver to correct errors in the standard GPS signals. These corrections are then broadcast and can be received by any user with a DGPS receiver. The corrections are applied within the user's receiver, providing mariners with a position that is accurate within 10 meters, with 99.7% probability. While DGPS is accurate to within 10 meters, improvements to receivers will make DGPS accurate to within a centimeter, noise-free and able to provide real-time updates.

The Coast Guard uses selected marine radiobeacons to send DGPS corrections to users. DGPS provides accurate and reliable navigating information to maritime users in Harbor Entrance and Approach (HEA), along U.S. coastal waters, the Great Lakes**,** navigable portions of the western rivers, Puerto Rico, Hawaii, and Alaska.

Radionavigation System Summary

D.8. General

The following is a summary of the different long range ATON used by mariners.

Summary of Radionavigation Systems			
System Parameters	**Loran-C**	**GPS**	**DGPS**
Signal Characteristics	Pulsed Hyperbolic (curved line), operating in the 90 to 110 kHz range.	Messages broadcast from satellites on two L-band frequencies: L1, 1575.42 MHz & L2, 1227.6 MHz.	Data messages broadcast from radiobeacon sites in 283 kHz to 325 kHz frequency band.
Predictable Accuracy	0.25 NM	100 m	10 m
Availability	99%+	99%+	99.7%
Coverage	U.S. Coastal areas, selected overseas areas.	Worldwide	U.S. coastal waters, Great Lakes, western rivers, P.R., HI, and AK.
Reliability	99.7% (Triad reliability).	99.79%	99.7%
Fix Rate	13-20 fixes/in.	Continuous	Continuous
Integrity	Steady monitoring: “stations” blink notifies pair is unusable, and detects flaws.	None	Yes, site monitored.

Summary of Radionavigation Systems			
System Parameters	**Loran-C**	**GPS**	**DGPS**
Advantages	Monitored, excellent integrity; some charts overlay Loran lines.	Accurate; available worldwide.	Extremely accurate and monitored.
Common Interference	Electromagnetic irregularities.	Shadows, signals blocked due to natural or man-made obstructions.	Shadows, signals blocked due to natural or man-made obstructions.
Caution: System specifications noted here may change at any time.			

Section E. The Light List

E.1. General

The *Light List* is a seven volume, annual publication providing information on ATON maintained or authorized by the U.S. Coast Guard located on coastal and inland waters. The volumes cover the U.S. and its possessions, including the Intracoastal Waterway, Western Rivers, and the Great Lakes for both U.S. and Canadian waters. Each volume contains information on ATON within its region maintained under the authority of the Coast Guard, including authorized private aids.

E.2. Contents

This publication includes detailed descriptions of both short range ATON and radionavigation systems, complete lists of lights for the area, Loran-C chains not shown on a nautical chart, and more.

E.3. Numbering sequence

The aids in the *Light List* are listed so that seacoast aids appear first, followed by entrance and harbor aids from seaward to the head of navigation. *Light List* Numbers (LLNR) are assigned to aids for easy reference and appear in sequence from:

- north to south along the Atlantic Coast
- south to north and east to west along the Gulf Coast
- south to north along the Pacific Coast.

E.4. General information section

The general information section offers information about the layout and organization of the *Light List*. It describes the U.S. system of ATON and its characteristics, and provides a glossary of terms.

E.5. Example of using the *Light List*

Determine the position and characteristic of Ocean City Inlet Jetty Light.

Take these steps to find this information in the *Light List*:

Step	Procedure
1	Use the *Light List* for that location (Volume II, Atlantic Coast).
2	Look up "Ocean City Inlet Jetty Light" in the index and note the LLNR. (See Figure 13-12). In this example, the LLNR is "230."
3	Find the correct page, listing LLNR 230. (See Figure 13-13.) Each ATON is listed numerically by LLNR.
4	Extract the information you need for the aid.

In this case, the position of the light is 38°19.5' N, 75°05.1' W; and the light characteristic is Isophase white 6 seconds. Note that across the top of each page is a column heading which explains the information listed in the column.

In this example, the Ocean City Inlet Jetty Light has what appears to be two LLNRs, 230 and 4485. Having two LLNRs means that this aid will be listed as a "seacoast" aid using LLNR 230 and again as a "harbor entrance" aid under Ocean City Inlet Jetty Light using LLNR 4485. Seacoast. ATON are indexed in the beginning of the *Light List*.

O

Oak Creek 26205
Oak Island Channel 30415
Oak Island Light 810
Oak Island Radiobeacon 815
Occohannock Creek 21695
Occoquan River 18265
Ocean City Inlet 4720
OCEAN CITY INLET
JETTY LIGHT 225
Ocean City Inlet
Radiobeacon 230
Ocean City Inlet Lighted
Bell Buoy 2 240
Ocean City Research Buoy 235
Ocean City Wreck Buoy
WR2 245
OCEAN PINES YACHT
CLUB 4925
Ocracoke Inlet 28895
Ocracoke Light 660

***Light List* Index**
Figure 13-12

(1) No.	(2) Name and location	(3) Position	(4) Characteristic	(5) Height	(6) Range	(7) Structure	(8) Remarks
	SEACOAST (Maryland) – Fifth District						
	OCEAN CITY INLET TO CAPE HATTERAS (Chart 12200)						
225 4720	OCEAN CITY INLET JETTY LIGHT	38 19.5 75 05.1	**Iso W** 6^{s}	28	8	NB on skeleton tower.	HORN: 1 blast ev 15^{s} (2^{s} bl).
230 4725	**Ocean City Inlet Radiobeacon**	38 19.5 75 05.3	**OC** (– – – – • – •)		10		FREQ: 293 kHz. Antenna located on Ocean City Inlet Jetty Light.
235	Ocean City Research Buoy	38 20.8 75 01.1				Yellow.	Maintained by U.S. Army Corps of Engineers.

***Light List* Excerpt**
Figure 13-13

E.6. Corrections

Corrections to *Light List* are made in the "Local Notice to Mariners" published by each Coast Guard district. These notices are essential for all navigators to keep their charts and *Light List*, current.

Appendix 13-A
U.S. Aids to Navigation System on Navigable Waters *Except the Western River System*

Insert Color Plate 1

Appendix 13-B
Visual Buoyage Guide

Insert Color Plate 2

Appendix 13-C
Fictitious Nautical Chart (How the Visual Guide Would Appear on a Nautical Chart)

Insert Color Plate 3

Appendix 13-D
U.S. Aids to Navigation System on the *Western River System* and the *Uniform State Waterway Marking System*

Insert Color Plate 4